MICROWAVE

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26 November 1947

MEMORANDUM FOR FILE:

Subject: The Kurier problem.

1. In the set of corrections and additions (dated November 1943) to the captured document "German U-Boat Communication's Regulations, 1942", the phrase, "Short Signal Procedure 'Kurier'" first came to the knowledge of the U.S. Navy. This lone reference to Kurier gave no explanation as to the meaning of the term. However, on 22 June 1944, intelligence was received which gave further evidence of the meaning of Kurier, and by 26 August 1944 it was realized that a radically new communication system was being introduced into German U-Boat operations. By 30 November 1944 further intelligence revealed that extensive tests had been undertaken in the Skagerrak and Kattegat, though details of the system were still unknown. As a result of intensive work by the U.S. Navy and the British (the latter actually intercepting Kurier signals for the first time), the essential elements of Kurier became known by the 18th of December 1944.

2. The Chief of Naval Communications was appraised of the seriousness posed by the Kurier procedure in a secret memorandum of 24 January 1945, and CNC Serial 00589020 was sent to the Chief of Electronics the following day. This letter requested the establishment of a $500,000 contract with a suitable radio engineering contractor and a $250,000 research fund at the MIT Radiation Laboratory as the first steps toward solving the problems of intercepting and D/F-ing Kurier transmissions.

3. This was the inevitable sequence followed by C.I. activities in war time: discovery of the problem, its analysis, and the search for a solution. Only five months had elapsed since the existence of the problem became known; only five weeks since the nature of the problem was discovered, until a research and developmen program aiming at the solution had been initiated.

4. The precise chronology of events is difficult to reconstruct, but the need for decisions arose during the months of Jan-

techniques had been given by the Germans to the Japanese. An operational attack on the Kurier system presented the following technical problems:

(a) Recognition

(The recognition code used in the Kurier system was known and devices to trigger such equipment as desired could be built, provided the signal could be led to the recognition device).

(b) Guard Receiver

(Work was commenced in the CSAW laboratories on the construction of a series of wide band receivers tuned to adjacent frequency bands and equipped with the above type recognition device. Recording the signal offered no great problem once it was received; magnetic recording being the first choice.

(c) Direction finding

(i) Conventional

(Tests were initiated to determine the feasibility of triggering a camera to photograph the highly transitory image of a Kurier signal on a DAJ Oscilloscope)

(ii) Unconventional

(Unconventional direction finding or position fixing methods were investigated).

5. The unconventional direction finding methods to be sought, leads from the main line of developments discussed so far, but its review is essential to an understanding of past events.

The establishment of a project to conduct development of a radio direction finder system, embodying the inverse loran (Time Differential or TIDIF) principle, was recommended to the Director of NRL on 26 December 1940, in a letter which included a 14 page technical review of the fundamental problem. The author, Lt. Cdr. Kenrick, USNR, was apparently on duty with NRL at this time. His speculations on several points are interesting in that they are borne out by engineers currently working on the problem. However it is unknown and doubtful if any work was undertaken as a result of this proposal.

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5. (Continued)
Logs going back to April 1943, describe a series of tests that Op-20-2 conducted on TIDIF during Spring of 1943 at Muirkirk, which involved the measurements of time delay on an incoming signal received simultaneously at Muirkirk and NRL. The time base was established by keying a TBK transmitter at NRL with the incoming signal.

The tests were declared unsuccessful by Lt. M. A. Anderson, USNR of Op-20-2 in a report dated 25 February 1944, because of the lack of side band content in the keyed telegraph signals, and the limited band pass of the communications receivers used.

It should be noted that the aforementioned tests were conducted only to investigate TIDIF methods and the motivation was presumably to determine whether the results of the currently available DAB and DAJ installations could be improved upon. Kurier was yet in the future.

The progress of these tests extended up through 26 December 1944 when a report prepared by Cdr. D.H. Menzel on the synchronization of TIDIF stations by ground vs. sky wave was discussed. At this point (and possibly yet unknown to Menzel) Kurier was making its first appearance as a new C.I. problem.

6. Historically then, the proposals and preliminary technical considerations of TIDIF predate the origin of the Kurier problem by almost two years. Thus, in February of 1945 when the urgency of solving Kurier was apparent, it was natural that the TIDIF techniques should be re-examined.

It should be noted that the primary emphasis was placed on D/F-ing Kurier and that the files disclose relatively little on the straight problems of Kurier intercept. This was presumably on the grounds that the D/F problem was the more difficult and that the intercept of Kurier could be achieved in the process of obtaining a Kurier bearing or fix. In order to D/F Kurier it is necessary to locate the signal in time and frequency, and to put the position fixing gear on this signal. When these two unknowns have been determined, the problem of placing a magnetic recorder on the signal is relatively simple.

The main research problem then was to develop equipment for D/F-ing Kurier.

7. The request made on 24 January 1945, for the support of a civilian contractor resulted in Contract NXsr 79987 with the Bell Telephone Laboratories, and the entire Kurier problem was placed before them (i.e. both intercept and direction finding). A preliminary report was submitted on 26 May 1945 ("Report on Chicago Pulse Tests-Panther Project") by B.T.L. as a result of

tests with two receiving stations at Holmdel, N.J., and Muirkirk, Maryland, connected by a metallic line.

This report concludes:

(i) "Neither TIDIF nor Adcock methods are as accurate on sky waves as on ground waves ---"

(ii) "TIDIF has shown up better than could have been expected from previous short wave experience. A useful system could no doubt be made ---"

(iii) "Neither TIDIF nor Adcock will be free of large errors ---"

(iv) "It is likely that Adcock accuracy will be equal to, or better than TIDIF on steep sided pulses ---"

This report further compares, and lists the advantages of both the Adcock and TIDIF systems with regard to operations against Kurier.

The final report prepared by B.T.L. (Report on Project PANTHER) was submitted 15 September 1945.

8. By the time Bell Laboratories completed their work on Kurier the Pacific as well as the Atlantic war was over and the Kurier problem was added to the list of those projects considered under "Post War Planning". This was in accordance with a memorandum from Op-20-2 dated 13 June 1945 which directed that a survey be made to determine desirable post-war locations in the Pacific and Atlantic for proper TIDIF coverage.

9. With the urgency for a Kurier solution removed, the planning departed from the idea of procuring individual stop-gap devices, and a comprehensive program was outlined during the Winter of 1945 and Spring of 1946 known as the "Automatic Pulse Intercept Program". This program was one of systems engineering and included development of

(i) Signal Analyzer (now Project SPINACH)

(ii) Microwave Link

(iii) TIDIF.

This program included both the intercept; and D/F phases of the Kurier problem, and more important, was based on the premise

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that TIDIF methods were the most promising of the various position fixing systems.

10. This "Automatic Pulse Intercept Program" was assigned to Northwestern Aeronautical Corporation (for accomplishment by ERA) under Contract NObs 28476 and became known as Project TURNIP. The objective of TURNIP was:

"To engineer and develop components for an automatic intercept system which includes the following process:

(a) Rapid remotely controlled receiver tuning

(b) Automatic recognition

(c) Recording

The techniques and equipments developed are to be, where feasible, used for automatic D/F operation."

The outlined approach was to be, briefly:

1. Development and construction of a microwave link.

2. Development of remote receiver tuning.

3. Development of recognition devices.

4. Development of recorders and time difference measuring equipment

11. Project TURNIP progressed slowly during the summer of 1946 although work proceeded along the several independent paths. The signal analyzer was developed, Model SJ Radars were under modification for microwave link Tests, and studies were made on TIDIF timing devices. Little or no work was done on remote receiver tuning and recognition devices.

12. On 22 August 1946, a set of tentative military characteristics were drawn up by N-52 for a microwave link which listed as necessary functional characteristics.

(i) Capable of relaying Kurier type signals.
(ii) Capable of relaying telecontrol signals for remote controlling of receivers.
(iii) Capable of relaying timing signals within a tolerance of ± one (1) microsecond.

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12. (Continued)

These military characteristics reduced to writing for the first time, ideas that had been discussed over a period of months. They represented however, a somewhat changed philosophy. Project TURNIP which had been under prosecution at ERA since the Spring of 1946, was a program to solve the Kurier problem. In the solution of this problem it was necessary to establish an accurate time base between two points (Cheltenham, Md., and DuPont, S.C.) separated by several hundreds of miles. The E.R.A. proposal under TURNIP, was to set up an experimental microwave link employing modified radar equipments from government surplus. The E.R.A. philosophy was to consider the initial microwave work as a large scale experiment in which TIDIF principles could be put to a test.

However, at a meeting held in the Bureau of Ships on 19 November 1946, it was agreed that the Bureau of Ships would take the initiative in setting up a program for the development of a microwave link and associated terminal equipment. At about that same time the portion of TURNIP concerned with the experimental microwave link was withdrawn from the ERA Contract. ERA concluded their work on the microwave link with a monthly progress report for January 1947.

The development of the signal analyzer was removed from Project TURNIP and set up as Project SPINACH, and Project TURNIP died a natural death at the expiration of Contract NObs-28476 with ERA's submission of reports on "Method of Measuring Time Differences for Time Difference Direction Finding" and "Remote Control Tuning Methods and Devices Applicable to Radio Receiving".

13. Progress on the microwave link was largely limited to the writing of specifications within the Bureau of Ships until 11 November 1947 when a proposal was received from Hazeltine Corporation in response to a Bureau of Ships invitation to accept a program of design and development for a radio position fixing, signal recording and signal analyzing system.

14. In essence the Hazeltine proposal has as immediate objectives, the realization of increased speed and certainty of correct operation of presently available direction finders, and as long range objectives, a material increase in the ultimate sensitivity of all position fixing equipment and to develop the technique of position fixing to an extent that it may be used on Kurier transmission.

With respect to the latter objective they propose:

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(A) Study of wave propagation in the frequency range 1 to 30 MC, analysis of its effect on radio position fixing systems, analysis of effects of propagation anomalies, etc.

(B) Study of the use of TIDIF for radio position fixing.

(C) Study of alternatives to TIDIF for radio position fixing.

15. It will be noticed that the three phases outlined above, which are a part of the long range objective, are almost identical with the tasks undertaken and reported on by Bell Laboratories in the Summer and Fall of 1945.

In criticizing the lack of concrete conclusions of the Bell Laboratories project, it should be remembered that it was established in the Spring of 1945 and concluded in September of that year, and that the experiments and studies conducted during those six or seven months comprise the only real advancement we have made since the introduction of the Kurier problem three years ago. In terms of equipment, we are not significantly better prepared for operating against Kurier than we were in January 1945.

16. The present status of the microwave project will be seen to have been the result of a complicated evolution, summarized as follows:

(1) Kurier system is introduced and becomes known by Op-20-2 in wartime. (January 1945)

(2) In an effort to develop systems capable of D/F-ing Kurier signals, Bell Laboratories is brought into problem. (March 1945)

(3) Bell Laboratory submits reports on TIDIF, and Adcock approaches to the Kurier problem. (September 1945)

(4) Based upon above reports, a pulse intercept program is established at ERA. A microwave link of interim, experimental nature is a required tool for this program. (May 1945)

(5) Military Characteristics for microwave link prepared. (August 1946)

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(6) Meeting held with BuShips on microwave Link and microwave link work at ERA cancelled. BuShips to initiate the microwave program. (November 1946)

(7) Proposal received from Hazeltine Corporation, to work on solution of Kurier problem. (November 1947)

In a sense we reached our "high-water mark" on the Kurier problem at step #3 (September 1945) for the reason that we are fundamentally no more able to cope with the Kurier problem now than then.

17. COMMENTS

The following approaches to a problem are frequently offered:

(a) To commence a research and development program from the experimental viewpoint, knowing that the equipment is in "breadboard" form and that it must be replaced within a short time, but knowing also that the surest way to get facts is to conduct the necessary tests and measurements.

(b) The other approach is the analytical and engineering one of establishing the theoretical requirements for the various equipments, and then proceed to have these equipments constructed.

The first method is the one originally decided upon for the pulse intercept program. ERA's construction of an experimental microwave link was to be the first step in a series of tests and experiments in which a number of operations essential to the Kurier solution could be evaluated. This method does have the weakness that most or all of the equipment would have to be replaced by production type equipment once the principles were established, and in this respect, might prove the more expensive. However, 'the longest journey begins with a single step', and this method would have taken that step.

The second approach, adopted in November 1946 when the first was abandoned, started out on the assumption that a microwave link would be established using presently available relay equipment in order that the link would be quickly available for tests, and then would eventually be modernized when improved relay equipment under development became available. This approach apparently succumbed

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to the powerful desire to "hold off until a better equipment is available". This being a completely understandable position from a material bureau's viewpoint, but resulting in the lengthy development necessary to produce improved link equipment suitable for, say, general communications (for which purpose operable equipment does exist), which is adequate also for our Kurier problem (for which no equipment exists). An ever present possibility is that our unique requirements will be coordinated to death in the effort to produce equipment satisfactory to users with diverse problems of greatly varying priorities.

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